FORMS PTO-1390 (REV 10-96) U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY'S DOCKET NUMBER	
SI01-012	
U.S. APPLICATION NO. (If known, see 37 CFR 1.5)	
10/031916	

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/DE00/02395	July 21, 2000	July 21, 1999

TITLE OF INVENTION

OPTICAL COUPLING DEVICE

APPLICANT(S) FOR DO/EO/US

Corning Incorporated

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C.371.
3. ☐ This express request to being national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
4. ☒ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   a. ☐ is transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☒ has been transmitted by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3)).
   a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☒ have been transmitted by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☐ have not been made and will not be made.
8. ☒ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☐ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. ☐ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11. To 16. Below concern document(s) or information included:

11. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☐ An Assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☒ A FIRST preliminary amendment.
14. ☐ A SECOND or SUBSEQUENT preliminary amendment.
15. ☐ A change of power of attorney and/or address letter.
16. ☒ Other items or information: -Original Translation of PCT Application
    -Version of Application With Markings to Show Changes Made
    -**CLEAN** Version of Amended Application, to be used for examination purposes

U.S. APPLICATION NO. (If known, see 37 CFR 1.5)	INTERNATIONAL APPLICATION NO	ATTORNEY'S DOCKET NUMBER
10/031916	PCT/DE00/02395	SI01-012

17. ☒ The following fees are submitted:

CALCULATIONS	PTO USE ONLY

BASIC NATIONAL FEE (37 CFR 1.492 (a)(1)-(5):

Neither international preliminary examination fee (37 DFR 1.482) nor international search fee (37 CFR 1 445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO **$1040.00**

International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO **$890.00**

International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1 445(a)(2)) paid to USPTO **$740.00**

International preliminary examination fee paid to USPTO (37 CFR 1.482) but all claims did not satisfy provisions of PCT Article 33 (1)-(4) **$710.00**

International preliminary examination fee paid to USPTO (37 CFR 1 482) and all claims satisfied provisions of PCT Article 33(1)-(4) **$100.00**

ENTER APPROPRIATE BASIC FEE AMOUNT = $890.00

Surcharge of **$130.00** for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(e)). $

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE	
Total claims	16- 20 =	0	X $18.00	$.00
Independent claims	1 - 3 =	0	X $84.00	$.00
MULTIPLE DEPENDANT CLAIM(S) (if applicable)			+ $270.00	$

TOTAL OF ABOVE CALCULATIONS = $890.00

Reduction of ½ for filing by small entity, if applicable. Verified Small Entity Statement must also be filed (Note 37 CFR 1.9, 1.27, 1.28) + $

SUBTOTAL = $890.00

Processing fee of **$130.00** for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(f)). + $

TOTAL NATIONAL FEE = $890.00

Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). **$40.00** per property + $

TOTAL FEES ENCLOSED = $.00

Amount to be refunded:	$
Charged:	$890.00

I hereby certify that this paper or fee is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 CFR 1 10 on the date indicated below and is Addressed to the Commissioner of Patents and Trademarks, Washington, DC 20231

on 1/19/02 (Date) By: Bethany Beligotti (Signature) Bethany Beligotti

"EXPRESS MAIL" Mailing Label No. EV041470304US

a. ☐ A check in the amount of $ _____ to cover the above fees is enclosed.

b. ☒ Corning Incorporated hereby authorizes use of **Deposit Account No. 03-3325** in the amount of $ 890.00 to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 03-3325. A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

Send all correspondence to:
Walter M. Douglas
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Walter M Douglas
Signature

Registration No.: 34,510
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SI01-012

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor:	R. Aigner et al.		
Serial No:	TBA	Art Group Unit:	TBA
Filing Date:	Herewith	Examiner:	TBA
Title:	OPTICAL COUPLING DEVICE	**PRELIMINARY AMENDMENT**	

Assistant Commissioner for Patents
Washington, DC 20231

PRELIMINARY AMENDMENT

Prior to examination of the above captioned application and issuing an office action on the merits, please enter this amendment, as set forth below.

IN THE SPECIFICATION

Please see attached application entitled "Clean Version of Amended Application".

IN THE CLAIMS

Please see attached application entitled "Clean Version of Amended Application".

REMARKS

This application is a national stage filing under 35 U.S.C. § 371 of PCT Application No. PCT/DE00/02397, filed July 21, 2000, which was filed in the German language. Enclosed herewith please find a copy of the application translated into English as received from the translating party, entitled "Original Translation". Also enclosed please find a copy of the application as amended with additions underlined and deletions in brackets, which application is entitled "Version of Application with Markings to Show Changes Made". Finally, enclosed please find a clean copy of the application as amended, entitled "Clean Version of Amended Application". Applicants enclose copies of the Version of Application with Markings to Show the Changes Made and a Clean Version of the Amended Application because under the new rules, we would have had to replace almost every paragraph in the application in this Preliminary Amendment. Applicants believe that no new subject matter has been added to the application.

Referring now to "Version of Application with Markings to Show Changes Made", a claim to the priority of the German application is made at the beginning of the application. A section titled "Brief Description Of The Drawing" was inserted into the application as Paragraph 0006. The content of Paragraph 0006 is taken from Paragraph 0021. Since there is only one figure in the application, a reference was added to "FIG.1."

The claims have been amended to remove the multiple dependency found in the original PCT claims.

The phrase "holding device" has been replaced by the phrase --holding element--. Please refer to the specification at Paragraph 0022, identifying holding device 12. The word "device " is changed to --element-- to avoid confusion between the holding element 12 and the overall optical coupling device of the invention. Where believed necessary in the specification or claims, the word "coupling" is added to clarify reference to coupling device of the invention.

The invention describes the coupling device as being used with two waveguides. The specification at Paragraph 0009 refers to the second optical waveguide as being an optical waveguide chip. Consequently, the application was amended to identify the optical fiber referred to in various places as being the "first" waveguide.

Applicants respectfully request that all amendments made herein be duly entered into the application.

Conclusion

Based upon the above amendments and remarks, Applicants believe the pending claims of the above-captioned application are in allowable form and patentable. Applicants respectfully request consideration of the application as amended and a prompt Notice of Allowance thereon.

Applicants believe that no extension of time is necessary to file this Preliminary Amendment. Should Applicants be mistaken, Applicants respectfully request that the Office grant such time extension pursuant to 37 C.F.R. § 1.136(a) as necessary to make this amendment timely, and hereby authorizes the Office to charge any necessary fee or surcharge with respect to said time extension to the deposit account of the undersigned firm of attorneys, Deposit Account 03-3325.

Please direct any questions or comments to Walter M. Douglas at (607) 974-2431.

Respectfully submitted,

CORNING INCORPORATED

Date: January 18, 2002

Date of Deposit: 1/19/02

I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being deposited with the United States Postal Service on the date indicated above with sufficient postage as first class mail in an envelope addressed to the Commissioner of Patents and Trademarks, Washington, DC 20231

Signature Bethany Beligotti

~~Walter M. Douglas~~ Bethany Beligotti

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CLEAN VERSION OF AMENDED APPLICATION SI01-012

OPTICAL COUPLING DEVICE

Priority Applications

[0001] This Application claims the benefit of priority under 35 U.S.C. §119 of German Patent Application No. 19934183.4, filed July 21, 1999, and is a national stage filing under 35 U.S.C. §371 of PCT Application No. PCT/DE00/02395, filed July 21, 2000.

Field of the Invention

[0002] The invention relates to an optical coupling device for injecting light between two optical-waveguide end faces, it being possible to vary the geometrical position of the one optical-waveguide end face, for example, an optical fiber, with respect to the other optical-waveguide end face, for example a fiber-optic chip, with the aid of a variable-length element which, via a holding device, carries the one of the two optical waveguides, and is fastened to the other optical waveguide through two holding blocks.

Background of the Invention

[0003] An optical coupling device is known, for example, from WO 98/13718. Such coupling devices are used in optical filters according to the phased-array principle with an injection face, which light enters at a specific geometrical position, the geometrical position influencing the output wavelength of the optical filter. Optical filters according to the phased-array principle are used, in particular, as multiplexers or demultiplexers in optical wavelength-multiplex operation (WDM), since they have a low input attenuation and high crosstalk suppression. The optical filter has, as its essential component, a plurality of curved optical waveguides of different length, which form a phase-shifter region.

[0004] German Patent Application DE 44 22 651.9 describes that the central wavelength of a phased-array filter can be established through the position of an injection optical waveguide, which guides the light into the optical waveguide. In this way, the central wavelength of the optical filter can be adjusted accurately through the geometrical positioning of the injection optical waveguide or the injection fiber. Since it is therefore desirable for the optical waveguides to be shifted relative to one another, the optical waveguides cannot be adhesively bonded directly to one another.

Summary of the Invention

[0005] In the optical coupling device described in the Field of the Invention, the holding blocks are fastened to the chip, and the optical fiber is held on the variable-length element. In this case, the variable-length element may oscillate or bend, which causes temporary or permanent deadjustment of the fiber, even though a certain degree of guiding is provided.

[0006] It is therefore an object of the invention to ensure improved guiding of the variable-length element parallel to its extension direction and to avoid deadjustment during operation.

Brief Description of the Drawing

[0007] FIG. 1 illustrates a side view of an exemplary embodiment of the Invention

Detailed Description of the Invention

[0008] The optical coupling device mentioned in the introduction is embodied in that the variable-length element, or the holding element, is held by a spring element, which is spongily or porously designed and which is supported directly or indirectly on at least one of the holding blocks and allows movements of the variable-length element, or the holding element, in the length direction of the variable-length element, in which the variable-length element is extended or shortened, and prevents movement of the variable-length element perpendicular to the length direction of the variable-length element. The variable-length element, which is necessarily fastened further away to the other optical waveguide, that is to say the planar waveguide, presses against the holding element for the fiber, in order to permit the relative movement of the fiber with respect to the planar waveguide. The spring element is configured in such a way that residual movement perpendicular to the plane is maximally suppressed. The effect achieved by this is that the movement of the fiber relative to the chip takes place very exactly parallel to the chip face and virtually no deadjustment perpendicular thereto occurs.

[0009] Since the spring element is spongily or porously designed and the wall thickness of the spring element is hence reduced in comparison with the wall thickness of the solid material, the desired elasticity or spring characteristic is imparted to the spring element. Through selection of the ratio between the remaining wall thickness and the hole size, it is advantageously possible to vary the elasticity in wide ranges.

[0010] In the invention, it is furthermore advantageous that the holding block can be adhesively bonded to the second optical waveguide (optical-waveguide chip, also known in the art as a planar waveguide) very close to the fiber, so that large levers are avoided. Undesired movements in the directions perpendicular to the desired extension of the variable-

length element are thereby reduced significantly.

[0011] An advantageous configuration of the coupling device according to the invention is that the variable-length element, the holding element and the spring element are arranged between the two holding blocks, and in that the holding element is designed integrally with the variable-length element and the spring element is designed separately therefrom. In this case, it is advantageous that the material of the spring element can be selected without having to take into account the requirements placed on the material of the variable-length element.

[0012] Another advantageous configuration of the coupling device according to the invention is that the variable-length element, the holding element and the spring element are arranged between the two holding blocks, and in that the holding element, the variable-length element and the spring element are designed integrally. This configuration has production-technology advantages and also has advantages relating to the operational reliability and the life of the arrangement.

[0013] Another advantageous configuration of the coupling device according to the invention is that the variable-length element, the holding element and the spring element are arranged between the two holding blocks, and in that the holding element and the spring element are designed integrally and the variable-length element is designed separately therefrom. Here again, it is possible to produce the holding elements and the spring element without having to pay attention to the material of the variable-length element.

[0014] Another advantageous configuration of the coupling device according to the invention is that the variable-length element, the holding element and the spring element are arranged between the two holding blocks, and in that the holding element, the spring element and the holding block connected thereto are designed integrally and the variable-length element is designed separately therefrom.

[0015] Another advantageous configuration of the coupling device according to the invention is that the spring element is formed by slots in the variable-length element, or the holding element, which lie in a plane parallel to the end faces and perpendicular to the length direction of the variable-length element. These slots can be employed particularly advantageously whenever the variable-length element, the holding element and the spring element, or alternatively at least the holding element and the spring element, are designed integrally with one another. The direction of the slots is also advantageous since, if the slots are rotated through 90°, for example, stability in the critical direction perpendicular to the chip plane is no longer sufficiently guaranteed.

[0016] Another advantageous configuration of the coupling device according to the invention is that an even number of slots is provided. Tilting tendencies can thereby be minimized.

[0017] Another advantageous configuration of the coupling device according to the invention is that the spring element is formed by bores in the variable-length element, or the holding element, which lie in a plane parallel to the end faces and perpendicular to the length direction of the variable-length element. Such bores are easy to machine-produce, it being possible to set the spring constant of the spring element through the size of the bores.

[0018] Another advantageous configuration of the coupling device according to the invention is that the length of the variable-length element is selected in such a way that the spring element is under prestress in the starting position of the variable-length element. This guarantees that, if it is designed separately from the variable-length element, the holding element follows the variable-length element when the latter contracts.

[0019] Another advantageous configuration of the coupling device according to the invention is that the two holding blocks are connected to one another by a link, the arrangement consisting of the two holding blocks, the variable-length element, the holding element and the spring element being provided with greater stability.

[0020] Another advantageous configuration of the coupling device according to the invention is that the two holding blocks are connected to one another by a frame, a respective link being provided at the top and at the bottom between the two holding blocks, and the links being produced in one piece with the holding blocks, so that they can be adhesively bonded with the latter to the chip.

[0021] Lastly, another advantageous configuration of the coupling device according to the invention is that the holding element has a ferrule in which the optical waveguide, or the optical fiber, is fastened. It would admittedly also be possible to fasten the fiber to the resilient element without a ferrule, for example by adhesive bonding in a V-groove. Nevertheless, it is preferable to use a ferrule owing to the accuracy of the fit and the avoidance of aging phenomena in the adhesive for adhesively bonding the fiber in the V-groove.

[0022] An exemplary embodiment of the invention will be described with the aid of the appended drawing, FIG. 1, which shows a side view of the exemplary embodiment of the coupling device according to the invention.

[0023] FIG.1 shows a side view of a coupling device according to an exemplary embodiment of the invention, in which two holding blocks 4, 6 (the first and second holding blocks, respectively) are fastened, for example adhesively bonded, on an optical-waveguide chip 2. The first holding block 4 carries a variable-length element 8. An optical fibre 10 is fastened to a holding element 12. The variable-length element 8 is clamped or adhesively bonded between the one holding block 4 and a holding element 12 for the fiber 10.

[0024] The variable-length element 8, or the holding element 12, is supported on the holding block 6 via a spring element 14. The spring element is formed by outer slots 16 and inner slots 18. The slots 16, 18 can also be replaced by bores. In the vicinity of the spring element 14, the material may also be spongily or porously designed.

[0025] For the spring element 14, it is only necessary for the wall thickness of the spring element to be reduced in comparison with the wall thickness of the solid material, in order to impart the desired elasticity or spring characteristic to the spring element 14. Through selection of the ratio between the remaining wall thickness and the hole size, it is possible to vary the elasticity in wide ranges.

[0026] In the exemplary embodiment that is shown, the two holding blocks 4, 6 are connected to one another via a link 20, which lies in the plane of the fiber-optic chip 2. The two holding blocks 4, 6 can also be connected to one another via a frame, which stands perpendicular to the face of the fiber-optic chip 2, which ensures that the coupling device overall is stabilized. In this exemplary embodiment, the links can be produced in one piece or adhesively bonded to one another.

Patent Claims

1. An optical coupling device for injecting light between end faces of two optical waveguides, said device comprising:

a first and second holding block;

a first and second optical waveguide, wherein the first of waid waveguides is an optical fiber and the second of said waveguides is a waveguide chip, and each of waid waveguides has an end face;

a holding element for holding said first optical waveguide;

a spring element supported in said first holding block;, and

an elongate variable-length element;

wherein said variable-length element is supported on said first holding block and its length is paralleled to the face of the second optical waveguide, and said variable-length element ends in contact with said holding element such that it is possible to vary the geometrical position of the first optical waveguide with respect to the second optical waveguide; and

wherein the spring element is positioned between the holding element attached to said variable-length element and the second holding block, and is supported on said second holding block, said spring element having the form of a spongy or porous body having holes selected from the group consisting of slots and bores extending perpendicular to the length direction of the variable-length element and paralleled to the end face of the second waveguide.

2. The device as claimed in claim 1, wherein the holding element is designed integrally with the variable-length element and the spring element is designed separately therefrom.

3. The device as claimed in claim 1, wherein the holding element, the variable-length element and the spring element are designed integrally.

4. The device as claimed in claim 1, wherein the holding element and the spring element are designed integrally and the variable-length element is designed separately therefrom.

5. The device as claimed in claim 1, wherein the holding element, the spring element and the holding block connected thereto are designed integrally and the variable-length element is designed separately therefrom.

6. The device as claimed in Claim1, wherein the number of slots or bores is an even number.

7. The device as claimed in claim 1, wherein the spring element is formed by slots in the variable-length element, or the holding element.

8. The device as claimed in claim 2, wherein the spring element is formed by slots in the variable-length element, or the holding element.

9. The device as claimed in claim 3, wherein the spring element is formed by slots in the variable-length element, or the holding element.

10. The device as claimed in claim 1, wherein the spring element is formed by bores in the variable-length element, or the holding element.

11. The device as claimed in claim 2, wherein the spring element is formed by bores in the variable-length element, or the holding element.

12. The device as claimed in claim 3, wherein the spring element is formed by bores in the variable-length element, or the holding element.

13. The device as claimed in claim1, wherein the length of the variable-length element is under prestress in the starting position of the variable-length element.

14. The device as claimed in claim 1, wherein the two holding blocks are connected to one another by a link.

15. The device as claimed in claim 1, characterized in that the two holding blocks are connected to one another by a frame, a respective link being provided at the top and at the bottom between the two holding blocks.

16. The device as claimed in claim 1, wherein the holding element is or contains a ferrule in which the optical waveguide, or the optical fiber, is fastened.

Abstract

Optical coupling device

An optical coupling device for injecting light between two optical-waveguide end faces, in which the geometrical position of the one optical-waveguide end face with respect to the other optical-waveguide end face can be varied with the aid of a variable-length element. The element carries one of the two optical waveguides, and is fastened to the other optical waveguide through a holding block. The variable-length element is held by a spring element, which is spongily or porously designed and which is supported directly or indirectly on at least one of the holding blocks and allows movements of the variable-length element in the length direction of the variable-length element, in which the variable-length element is extended or shortened, and prevents movement of the variable-length element perpendicular to the length direction of the variable-length element. The spring element is spongily or porously designed.

VERSION OF APPLICATION WITH MARKINGS TO SHOW CHANGES MADE

SI01-012

OPTICAL COUPLING DEVICE

Priority Applications

[0001] This Application claims the benefit of priority under 35 U.S.C. §119 of German Patent Application No. 19934183.4, filed July 21, 1999, and is a national stage filing under 35 U.S.C. §371 of PCT Application No. PCT/DE00/02395, filed July 21, 2000.

Field of the Invention

[0002] The invention relates to an optical coupling device for injecting light between two optical-waveguide end faces, it being possible to vary the geometrical position of the one optical-waveguide end face, for example, an optical fiber, with respect to the other optical-waveguide end face, for example a fiber-optic chip, with the aid of a variable-length element which, via a holding device, carries the one of the two optical waveguides, and is fastened to the other optical waveguide through two holding blocks.

Background of the Invention

[0003] An optical coupling device is known, for example, from WO 98/13718. Such coupling devices are used in optical filters according to the phased-array principle with an injection face, which light enters at a specific geometrical position, the geometrical position influencing the output wavelength of the optical filter. Optical filters according to the phased-array principle are used, in particular, as multiplexers or demultiplexers in optical wavelength-multiplex operation (WDM), since they have a low input attenuation and high crosstalk suppression. The optical filter has, as its essential component, a plurality of curved optical waveguides of different length, which form a phase-shifter region.

[0004] German Patent Application DE 44 22 651.9 describes that the central wavelength of a phased-array filter can be established through the position of an injection optical waveguide, which guides the light into the optical waveguide. In this way, the central wavelength of the optical filter can be adjusted accurately through the geometrical positioning of the injection optical waveguide or the injection fiber. Since it is therefore desirable for the optical waveguides to be shifted relative to one another, the optical waveguides cannot be adhesively bonded directly to one another.

Summary of the Invention

[0005] In the optical coupling device [cited] described in the [introduction] Field of the Invention, the holding blocks are fastened to the chip, and the optical fiber is held on the variable-length element. In this case, the variable-length element may oscillate or bend, which causes temporary or permanent deadjustment of the fiber, even though a certain degree of guiding is provided.

[0006] It is therefore an object of the invention to ensure improved guiding of the variable-length element parallel to its extension direction and to avoid deadjustment during operation.

Brief Description of the Drawing

[0007] FIG. 1 illustrates a side view of an exemplary embodiment of the Invention

Detailed Description of the Invention

[0008] The [To achieve this object, the] optical coupling device mentioned in the introduction is embodied [characterized] in that the variable-length element, or the holding element [device], is held by a spring element, which is spongily or porously designed and which is supported directly or indirectly on at least one of the holding blocks and allows movements of the variable-length element, or the holding element [device], in the length direction of the variable-length element, in which the variable-length element is extended or shortened, and prevents movement of the variable-length element perpendicular to the length direction of the variable-length element. The variable-length element, which is necessarily fastened further away to the other optical waveguide, that is to say the planar waveguide [chip], presses against the holding element [device] for the fiber, in order to permit the relative movement of the fiber with respect to the planar waveguide [chip]. The spring element is configured in such a way that residual movement perpendicular to the plane is maximally suppressed. The effect achieved by this is that the movement of the fiber relative to the chip takes place very exactly parallel to the chip face and virtually no deadjustment perpendicular thereto occurs.

[0009] Since the spring element is spongily or porously designed and the wall thickness of the spring element is hence reduced in comparison with the wall thickness of the solid material, the desired elasticity or spring characteristic is imparted to the spring element. Through selection of the ratio between the remaining wall thickness and the hole size, it is advantageously possible to vary the elasticity in wide ranges.

[0010] In the invention, it is furthermore advantageous that the holding block can be adhesively bonded to the second optical waveguide (optical-waveguide chip, also known in

the art as a planar waveguide) very close to the fiber, so that large levers are avoided. Undesired movements in the directions perpendicular to the desired extension of the variable-length element are thereby reduced significantly.

[0011] An advantageous configuration of the coupling device according to the invention is [characterized in] that the variable-length element, the holding element [device] and the spring element are arranged between the two holding blocks, and in that the holding element [device] is designed integrally with the variable-length element and the spring element is designed separately therefrom. In this case, it is advantageous that the material of the spring element can be selected without having to take into account the requirements placed on the material of the variable-length element.

[0012] Another advantageous configuration of the coupling device according to the invention is [characterized in] that the variable-length element, the holding element [device] and the spring element are arranged between the two holding blocks, and in that the holding element [device], the variable-length element and the spring element are designed integrally. This configuration has production-technology advantages and also has advantages relating to the operational reliability and the life of the arrangement.

[0013] Another advantageous configuration of the coupling device according to the invention is [characterized in] that the variable-length element, the holding element [device] and the spring element are arranged between the two holding blocks, and in that the holding element [device] and the spring element are designed integrally and the variable-length element is designed separately therefrom. Here again, it is possible to produce the holding elements [devices] and the spring element without having to pay attention to the material of the variable-length element.

[0014] Another advantageous configuration of the coupling device according to the invention is [characterized in] that the variable-length element, the holding element [device] and the spring element are arranged between the two holding blocks, and in that the holding element [device], the spring element and the holding block connected thereto are designed integrally and the variable-length element is designed separately therefrom.

[0015] Another advantageous configuration of the coupling device according to the invention is [characterized in] that the spring element is formed by slots in the variable-length element, or the holding element [device], which lie in a plane parallel to the end faces and perpendicular to the length direction of the variable-length element. These slots can be employed particularly advantageously whenever the variable-length element, the holding

element [device] and the spring element, or alternatively at least the holding element [device] and the spring element, are designed integrally with one another. The direction of the slots is also advantageous since, if the slots are rotated through 90°, for example, stability in the critical direction perpendicular to the chip plane is no longer sufficiently guaranteed.

[0016] Another advantageous configuration of the coupling device according to the invention is [characterized in] that an even number of slots is provided. Tilting tendencies can thereby be minimized.

[0017] Another advantageous configuration of the coupling device according to the invention is [characterized in] that the spring element is formed by bores in the variable-length element, or the holding element [device], which lie in a plane parallel to the end faces and perpendicular to the length direction of the variable-length element. Such bores are easy to machine-produce, it being possible to set the spring constant of the spring element through the size of the bores.

[0018] Another advantageous configuration of the coupling device according to the invention is [characterized in] that the length of the variable-length element is selected in such a way that the spring element is under prestress in the starting position of the variable-length element. This guarantees that, if it is designed separately from the variable-length element, the holding element [device] follows the variable-length element when the latter contracts.

[0019] Another advantageous configuration of the coupling device according to the invention is [characterized in] that the two holding blocks are connected to one another by a link, the arrangement consisting of the two holding blocks, the variable-length element, the holding element [device] and the spring element being provided with greater stability.

[0020] Another advantageous configuration of the coupling device according to the invention is [characterized in] that the two holding blocks are connected to one another by a frame, a respective link being provided at the top and at the bottom between the two holding blocks, and the links being produced in one piece with the holding blocks, so that they can be adhesively bonded with the latter to the chip.

[0021] Lastly, another advantageous configuration of the coupling device according to the invention is [characterized in] that the holding element [device] has a ferrule in which the optical waveguide, or the optical fiber, is fastened. It would admittedly also be possible to fasten the fiber to the resilient element without a ferrule, for example by adhesive bonding in a V-groove. Nevertheless, it is preferable to use a ferrule owing to the accuracy of the fit and

the avoidance of aging phenomena in the adhesive for adhesively bonding the fiber in the V-groove.

[0022] An exemplary embodiment of the invention will be described with the aid of the appended drawing, FIG. 1, which shows a side view of the exemplary embodiment of the coupling device according to the invention.

[0023] FIG.1 [The figure] shows a side view of a coupling device according to an exemplary embodiment of the invention, in which two holding blocks 4, 6 (the first and second holding blocks, respectively) are fastened, for example adhesively bonded, on an optical-waveguide chip 2. The first holding block [One of the holding blocks] 4 carries a variable-length element 8. An optical fibre [A fiber] 10 is fastened to a holding element [device]12. The variable-length element 8 is clamped or adhesively bonded between the one holding block 4 and a holding element [part] 12 for the fiber 10.

[0024] The variable-length element 8, or the holding element [part] 12, is supported on the holding block 6 via a spring element 14. The spring element is formed by outer slots 16 and inner slots 18. The slots 16, 18 can also be replaced by bores. In the vicinity of the spring element 14, the material may also be spongily or porously designed.

[0025] For the spring element 14, it is only necessary for the wall thickness of the spring element to be reduced in comparison with the wall thickness of the solid material, in order to impart the desired elasticity or spring characteristic to the spring element 14. Through selection of the ratio between the remaining wall thickness and the hole size, it is possible to vary the elasticity in wide ranges.

[0026] In the exemplary embodiment that is shown, the two holding blocks 4, 6 are connected to one another via a link 20, which lies in the plane of the fiber-optic chip 2. The two holding blocks 4, 6 can also be connected to one another via a frame, which stands perpendicular to the face of the fiber-optic chip 2, which ensures that the coupling device overall is stabilized. In this exemplary embodiment, the links can be produced in one piece or adhesively bonded to one another.

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[Patent Claims]

1. [An optical coupling device for injecting light between two optical-waveguide end faces, it being possible to vary the geometrical position of the one optical-waveguide end face, for example an optical fiber, with respect to the other optical-waveguide end face, for example a fiber-optic chip, with the aid of a variable-length element which, via a holding device, carries the one of the two optical waveguides, and is fastened to the other optical waveguide through a holding block, characterized in that the variable-length element (8), or the holding device (12), is held by a spring element (14), the spring element (14) is spongily or porously designed and is supported directly or indirectly on at least one of the holding blocks (4, 6) and allows movements of the variable-length element, or the holding device, in the length direction of the variable-length element, in which the variable-length element is extended or shortened, and prevents movement of the variable-length element perpendicular to the length direction of the variable-length element.]

2. [The device as claimed in claim 1, characterized in that the variable-length element (8), the holding device and the spring element (6) are arranged between the two holding blocks (4, 6), and in that the holding device is designed integrally with the variable-length element and the spring element is designed separately therefrom.]

3. [The device as claimed in claim 1, characterized in that the variable-length element (8), the holding device and the spring element are arranged between the two holding blocks (4, 6), and in that the holding device, the variable-length element and the spring element are designed integrally.]

4. [The device as claimed in claim 1, characterized in that the variable-length element (8), the holding device (12) and the spring element (14) are arranged between the two holding blocks (4, 6), and in that the holding device and the spring element are designed integrally and the variable-length element is designed separately therefrom.]

5. [The device as claimed in claim 1, characterized in that the variable-length element (8), the holding device (12) and the spring element (14) are arranged between the two holding blocks (4, 6), and in that the holding device, the spring element and the holding block (6) connected thereto are designed integrally and the variable-length element is designed separately therefrom.]

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6. [The device as claimed in one of claims 1 to 5, characterized in that the spring element (14) is formed by slots (16, 18) in the variable-length element (8), or the holding device, which lie in a plane perpendicular to the length direction of the variable-length element, the open edges lying perpendicular to the chip plane.]

7. [The device as claimed in claim 6, characterized in that an even number of slots are provided.]

8. [The device as claimed in one of claims 1 to 5, characterized in that the spring element (14) is formed by bores in the variable-length element (8), or the holding device, which lie in a plane parallel to the end faces of the optical waveguides and perpendicular to the length direction of the variable-length element.

9. [The device as claimed in one of the preceding claims, characterized in that the length of the variable-length element is selected in such a way that the spring element is under prestress in the starting position of the variable-length element.]

10. [The device as claimed in one of the preceding claims, characterized in that the two holding blocks (4, 6) are connected to one another by a link (20).]

11. [The device as claimed in claim 1, characterized in that the two holding blocks are connected to one another by a frame, a respective link being provided at the top and at the bottom between the two holding blocks.]

12. [The device as claimed in one of the preceding claims, characterized in that the holding device is a ferrule in which the optical waveguide (10), or the optical fiber, is fastened.]

PCT Amended Claims --7 to 8--

1. An optical coupling device for injecting light between end faces of two optical waveguides, said device comprising:

a first and second holding block;

a first and second optical waveguide, wherein the first of waid waveguides is an optical fiber and the second of said waveguides is a waveguide chip, and each of waid waveguides has an end face;

a holding element for holding said first optical waveguide;

a spring element supported in said first holding block;, and

an elongate variable-length element;

wherein said variable-length element is supported on said first holding block and its length is paralleled to the face of the second optical waveguide, and said variable-length element ends in contact with said holding element such that it is possible to vary the geometrical position of the first optical waveguide with respect to the second optical waveguide; and

wherein the spring element is positioned between the holding element attached to said variable-length element and the second holding block, and is supported on said second holding block, said spring element having the form of a spongy or porous body having holes selected from the group consisting of slots and bores extending perpendicular to the length direction of the variable-length element and paralleled to the end face of the second waveguide.

[(2, 10), having a holding device for holding the one optical waveguide (10), a holding block (4) which is fitted on the other optical waveguide (2), an elongate variable-length element (8) which is supported on the one holding block (4) and extends in its length direction, starting from the one holding block (4), parallel to the end face of the other optical waveguide (2) and on which the holding device is provided, so that it is possible to vary the geometrical position of the end face of the one optical waveguide (10), for example an optical fiber, with respect to the end face of the other optical waveguide (2), for example a fiber-optic chip, another holding block (6) which is arranged, with respect to the length direction of the variable-length element (8), on the side thereof remote from the one holding block (4), and a spring element (14) which is arranged between the variable-length element (8) and the other holding block (6) and is supported thereon, and on which the variable-length element (8) with the holding device provided thereon is held, characterized in that the spring element (14) is designed in the form of a spongy or porous body having holes extending perpendicular to the length direction of the variable-length element (8) and parallel to the end face of the other optical waveguide (2).]

2. The device as claimed in claim 1, wherein [characterized in that] the holding element [device] is designed integrally with the variable-length element [(8)]and the spring element [(14)] is designed separately therefrom.

3. The device as claimed in claim 1, wherein [characterized that] the holding element [device], the variable-length element [(8)] and the spring element [(14)] are designed integrally.

4. The device as claimed in claim 1, wherein [characterized in that] the holding element [device] and the spring element [(14)] are designed integrally and the variable-length element [(8)] is designed separately therefrom.

5. The device as claimed in claim 1, wherein [characterized in that] the holding element [device], the spring element [(14)] and the holding block [(6)] connected thereto are designed integrally and the variable-length element [(8)] is designed separately therefrom.

6. The device as claimed in Claim1, wherein the number of slots or bores is an even number.

7 [6]. The device as claimed in claim 1, wherein [one of claims 1 to 5, characterized in that] the spring element [(14)] is formed by slots [(16, 18)] in the variable-length element [(8)], or the holding element [device].

8. The device as claimed in claim 2, wherein the spring element is formed by slots in the variable-length element, or the holding element.

9 The device as claimed in claim 3, wherein the spring element is formed by slots in the variable-length element, or the holding element.

[7. The device as claimed in claim 6, characterized in that an even number or slots or bores is provided.]

10. [8.] The device as claimed in claim 1, wherein [one of claims 1 to 5, characterized in that] the spring element [(14)] is formed by bores in the variable-length element [(8)], or the holding element [device].

11. The device as claimed in claim 2, wherein the spring element is formed by bores in the variable-length element , or the holding element.

12. The device as claimed in claim 3, wherein the spring element is formed by bores in the variable-length element , or the holding element.

13. [9.] The device as claimed in claim1, wherein [one of the preceding claims, characterized in that] the length of the variable-length element [(8) is selected in such a way that the spring element [(14)] is under prestress in the starting position of the variable-length element [(8)].

14. [10.] The device as claimed in claim 1, wherein [one of the preceding claims, characterized in that] the two holding blocks [(4, 6)] are connected to one another by a link [(20)].

15. [11.] The device as claimed in claim 1, characterized in that the two holding blocks [(4, 6)] are connected to one another by a frame, a respective link being provided at the top and at the bottom between the two holding blocks [(4, 6)].

16. [12.] The device as claimed in claim 1, wherein [one of the preceding claims, characterized in that] the holding element [device] is or contains a ferrule in which the optical waveguide [(10)], or the optical fiber, is fastened.

Abstract

Optical coupling device

An optical coupling device for injecting light between two optical-waveguide end faces, in which the geometrical position of the one optical-waveguide end face with respect to the other optical-waveguide end face can be varied with the aid of a variable-length element. The element carries one of the two optical waveguides, and is fastened to the other optical waveguide through a holding block. The variable-length element is held by a spring element, which is spongily or porously designed and which is supported directly or indirectly on at least one of the holding blocks and allows movements of the variable-length element in the length direction of the variable-length element, in which the variable-length element is extended or shortened, and prevents movement of the variable-length element perpendicular to the length direction of the variable-length element. The spring element is spongily or porously designed.

[Figure 1]

Original Translation

PCT/DE00/02395

Description

Optical coupling device

The invention relates to an optical coupling device for injecting light between two optical-waveguide end faces, it being possible to vary the geometrical position of the one optical-waveguide end face, for example, an optical fiber, with respect to the other optical-waveguide end face, for example a fiber-optic chip, with the aid of a variable-length element which, via a holding device, carries the one of the two optical waveguides, and is fastened to the other optical waveguide through two holding blocks.

An optical coupling device is known, for example, from WO 98/13718. Such coupling devices are used in optical filters according to the phased-array principle with an injection face, which light enters at a specific geometrical position, the geometrical position influencing the output wavelength of the optical filter. Optical filters according to the phased-array principle are used, in particular, as multiplexers or demultiplexers in optical wavelength-multiplex operation (WDM), since they have a low input attenuation and high crosstalk suppression. The optical filter has, as its essential component, a plurality of curved optical waveguides of different length, which form a phase-shifter region.

German Patent Application DE 44 22 651.9 describes that the central wavelength of a phased-array filter can be established through the position of an injection optical waveguide, which guides the light into the optical waveguide. In this way, the central wavelength of the optical filter can be adjusted accurately through the geometrical positioning of the injection optical waveguide or the injection fiber. Since it is therefore desirable for the optical waveguides to be shifted relative to one another, the optical waveguides cannot be adhesively bonded directly to one another.

In the optical coupling device cited in the

introduction, the holding blocks are fastened to the chip, and the optical fiber is held on the variable-length element. In this case, the variable-length element may oscillate or bend, which causes temporary or permanent deadjustment of the fiber, even though a certain degree of guiding is provided.

It is therefore an object of the invention to ensure improved guiding of the variable-length element parallel to its extension direction and to avoid deadjustment during operation.

To achieve this object, the optical coupling device mentioned in the introduction is characterized in that the variable-length element, or the holding device, is held by a spring element, which is spongily or porously designed and which is supported directly or indirectly on at least one of the holding blocks and allows movements of the variable-length element, or the holding device, in the length direction of the variable-length element, in which the variable-length element is extended or shortened, and prevents movement of the variable-length element perpendicular to the length direction of the variable-length element. The variable-length element, which is necessarily fastened further away to the other optical waveguide, that is to say the chip, presses against the holding device for the fiber, in order to permit the relative movement of the fiber with respect to the chip. The spring element is configured in such a way that residual movement perpendicular to the plane is maximally suppressed. The effect achieved by this is that the movement of the fiber relative to the chip takes place very exactly parallel to the chip face and virtually no deadjustment perpendicular thereto occurs.

Since the spring element is spongily or porously designed and the wall thickness of the spring element is hence reduced in comparison with the wall thickness of the solid material, the desired elasticity or spring characteristic is imparted to the spring element. Through selection of the ratio between the

remaining wall thickness and the hole size, it is advantageously possible to vary the elasticity in wide ranges.

In the invention, it is furthermore advantageous that the holding block can be adhesively bonded to the second optical waveguide (optical-waveguide chip) very close to the fiber, so that large levers are avoided. Undesired movements in the directions perpendicular to the desired extension of the variable-length element are thereby reduced significantly.

An advantageous configuration of the device according to the invention is characterized in that the variable-length element, the holding device and the spring element are arranged between the two holding blocks, and in that the holding device is designed integrally with the variable-length element and the spring element is designed separately therefrom. In this case, it is advantageous that the material of the spring element can be selected without having to take into account the requirements placed on the material of the variable-length element.

Another advantageous configuration of the device according to the invention is characterized in that the variable-length element, the holding device and the spring element are arranged between the two holding blocks, and in that the holding device, the variable-length element and the spring element are designed integrally. This configuration has production-technology advantages and also has advantages relating to the operational reliability and the life of the arrangement.

Another advantageous configuration of the device according to the invention is characterized in that the variable-length element, the holding device and the spring element are arranged between the two holding blocks, and in that the holding device and the spring element are designed integrally and the variable-length element is designed separately

therefrom. Here again, it is possible to produce the holding devices and the spring element without having to pay attention to the material of the variable-length element.

Another advantageous configuration of the device according to the invention is characterized in that the variable-length element, the holding device and the spring element are arranged between the two holding blocks, and in that the holding device, the spring element and the holding block connected thereto are designed integrally and the variable-length element is designed separately therefrom.

Another advantageous configuration of the device according to the invention is characterized in that the spring element is formed by slots in the variable-length element, or the holding device, which lie in a plane parallel to the end faces and perpendicular to the length direction of the variable-length element. These slots can be employed particularly advantageously whenever the variable-length element, the holding device and the spring element, or alternatively at least the holding device and the spring element, are designed integrally with one another. The direction of the slots is also advantageous since, if the slots are rotated through 90°, for example, stability in the critical direction perpendicular to the chip plane is no longer sufficiently guaranteed.

Another advantageous configuration of the device according to the invention is characterized in that an even number of slots are provided. Tilting tendencies can thereby be minimized.

Another advantageous configuration of the device according to the invention is characterized in that the spring element is formed by bores in the variable-length element, or the holding device, which lie in a plane parallel to the end faces and perpendicular to the length direction of the variable-length element. Such bores are easy to machine-produce,

it being possible to set the spring constant of the spring element through the size of the bores.

Another advantageous configuration of the device according to the invention is characterized in that the length of the variable-length element is selected in such a way that the spring element is under prestress in the starting position of the variable-length element. This guarantees that, if it is designed separately from the variable-length element, the holding device follows the variable-length element when the latter contracts.

Another advantageous configuration of the device according to the invention is characterized in that the two holding blocks are connected to one another by a link, the arrangement consisting of the two holding blocks, the variable-length element, the holding device and the spring element being provided with greater stability.

Another advantageous configuration of the device according to the invention is characterized in that the two holding blocks are connected to one another by a frame, a respective link being provided at the top and at the bottom between the two holding blocks, and the links being produced in one piece with the holding blocks, so that they can be adhesively bonded with the latter to the chip.

Lastly, another advantageous configuration of the device according to the invention is characterized in that the holding device has a ferrule in which the optical waveguide, or the optical fiber, is fastened. It would admittedly also be possible to fasten the fiber to the resilient element without a ferrule, for example by adhesive bonding in a V-groove. Nevertheless, it is preferable to use a ferrule owing to the accuracy of the fit and the avoidance of aging phenomena in the adhesive for adhesively bonding the fiber in the V-groove.

An exemplary embodiment of the invention will be described with the aid of the appended drawing,

which shows a side view of the exemplary embodiment of the coupling device according to the invention.

The figure shows a side view of a coupling device according to an exemplary embodiment of the invention, in which two holding blocks 4, 6 are fastened, for example adhesively bonded, on an optical-waveguide chip 2. One of the holding blocks 4 carries a variable-length element 8. A fiber 10 is fastened to a holding device 12. The variable-length element 8 is clamped or adhesively bonded between the one holding block 4 and a holding part 12 for the fiber 10.

The variable-length element 8, or the holding part 12, is supported on the holding block 6 via a spring element 14. The spring element is formed by outer slots 16 and inner slots 18. The slots 16, 18 can also be replaced by bores. In the vicinity of the spring element 14, the material may also be spongily or porously designed.

For the spring element 14, it is only necessary for the wall thickness of the spring element to be reduced in comparison with the wall thickness of the solid material, in order to impart the desired elasticity or spring characteristic to the spring element 14. Through selection of the ratio between the remaining wall thickness and the hole size, it is possible to vary the elasticity in wide ranges.

In the exemplary embodiment that is shown, the two holding blocks 4, 6 are connected to one another via a link 20, which lies in the plane of the fiber-optic chip 2. The two holding blocks 4, 6 can also be connected to one another via a frame, which stands perpendicular to the face of the fiber-optic chip 2, which ensures that the coupling device overall is stabilized. In this exemplary embodiment, the links can be produced in one piece or adhesively bonded to one another.

Patent Claims

1. An optical coupling device for injecting light between two optical-waveguide end faces, it being possible to vary the geometrical position of the one optical-waveguide end face, for example an optical fiber, with respect to the other optical-waveguide end face, for example a fiber-optic chip, with the aid of a variable-length element which, via a holding device, carries the one of the two optical waveguides, and is fastened to the other optical waveguide through a holding block, characterized in that the variable-length element (8), or the holding device (12), is held by a spring element (14), the spring element (14) is spongily or porously designed and is supported directly or indirectly on at least one of the holding blocks (4, 6) and allows movements of the variable-length element, or the holding device, in the length direction of the variable-length element, in which the variable-length element is extended or shortened, and prevents movement of the variable-length element perpendicular to the length direction of the variable-length element.

2. The device as claimed in claim 1, characterized in that the variable-length element (8), the holding device and the spring element (6) are arranged between the two holding blocks (4, 6), and in that the holding device is designed integrally with the variable-length element and the spring element is designed separately therefrom.

3. The device as claimed in claim 1, characterized in that the variable-length element (8), the holding device and the spring element are arranged between the two holding blocks (4, 6), and in that the holding device, the variable-length element and the spring element are designed integrally.

4. The device as claimed in claim 1, characterized in that the variable-length element (8), the holding device (12) and the spring element (14) are arranged between the two holding blocks (4, 6), and in that the holding device and the spring element are designed

integrally and the variable-length element is designed separately therefrom.

5. The device as claimed in claim 1, characterized in that the variable-length element (8), the holding device (12) and the spring element (14) are arranged between the two holding blocks (4, 6), and in that the holding device, the spring element and the holding block (6) connected thereto are designed integrally and the variable-length element is designed separately therefrom.

6. The device as claimed in one of claims 1 to 5, characterized in that the spring element (14) is formed by slots (16, 18) in the variable-length element (8), or the holding device, which lie in a plane perpendicular to the length direction of the variable-length element, the open edges lying perpendicular to the chip plane.

7. The device as claimed in claim 6, characterized in that an even number of slots are provided.

8. The device as claimed in one of claims 1 to 5, characterized in that the spring element (14) is formed by bores in the variable-length element (8), or the holding device, which lie in a plane parallel to the end faces of the optical waveguides and perpendicular to the length direction of the variable-length element.

9. The device as claimed in one of the preceding claims, characterized in that the length of the variable-length element is selected in such a way that the spring element is under prestress in the starting position of the variable-length element.

10. The device as claimed in one of the preceding claims, characterized in that the two holding blocks (4, 6) are connected to one another by a link (20).

11. The device as claimed in claim 1, characterized in that the two holding blocks are connected to one another by a frame, a respective link being provided at the top and at the bottom between the two holding blocks.

12. The device as claimed in one of the preceding

claims, characterized in that the holding device is a ferrule in which the optical waveguide (10), or the optical fiber, is fastened.

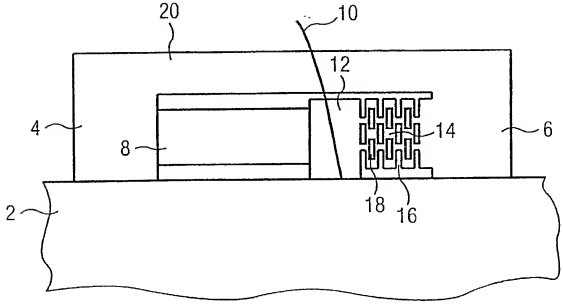
Original Translation PCT/DE00/02395

Abstract

Optical coupling device

An optical coupling device for injecting light between two optical-waveguide end faces, in which the geometrical position of the one optical-waveguide end face with respect to the other optical-waveguide end face can be varied with the aid of a variable-length element. The element carries one of the two optical waveguides, and is fastened to the other optical waveguide through a holding block. The variable-length element is held by a spring element, which is spongily or porously designed and which is supported directly or indirectly on at least one of the holding blocks and allows movements of the variable-length element in the length direction of the variable-length element, in which the variable-length element is extended or shortened, and prevents movement of the variable-length element perpendicular to the length direction of the variable-length element. The spring element is spongily or porously designed.

Figure 1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DECLARATION IN ORIGINAL APPLICATION **U.S. Attorney Docket No.: SI01-012**

As a below named inventor, I declare that:

My residence, Post Office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled **OPTICAL COUPLING DEVICE.**

The specification of which (check only one item below):

☐ is attached hereto

☒ was filed as United States Application Serial No. 10/031,916 on 1/19/02 and was amended on (if applicable)

☐ was filed as PCT international application number , on , and was amended under PCT Article 19 on (if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, § 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, § 119(a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate or 365(a) of any PCT international application which designated at least one country other than the Unites States, listed below and have also identified below any foreign application for patent or inventor's certificate, on the same subject matter, having a filing date before that of the application on which priority is claimed:

☒ **Country:** Germany **Application No.:** 19934183.4 **Filing Date:** 7/21/99

☐ **NONE**

I hereby claim the benefit under Title 35 United States Code § 119(e) and § 120 of any United States application(s) or 365(c) of any PCT international application designating the United States listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35 United States Code § 112, I acknowledge the duty to disclose material information as defined in Title 37 Code of Federal Regulations, § 1.56 which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

☐	**Provisional No.:**	**Filed:**	**Status:**
☒	**Application No.:**	**Filed:**	**Status:**
	PCT Application No: PCT/DE00/02395	**Filed:** 7/21/00	**Status:** filed

☐ **NONE**

DECLARATION IN ORIGINAL APPLICATION **U.S. Attorney Docket No.: SI01-012**

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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